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(54) Capacity controller of a compressor with variable capacity

(57) A small sized and structurally simple capacity controller having a wide control range of a compressor with variable capacity adds a differential pressure to an inhalation pressure on an arbitrary level by a piston valve body actuated by a solenoid and by the inhalation pressure. Said differential pressure is transmitted into a capacity variation mechanism of the compressor in order to change the capacity of the compressor.

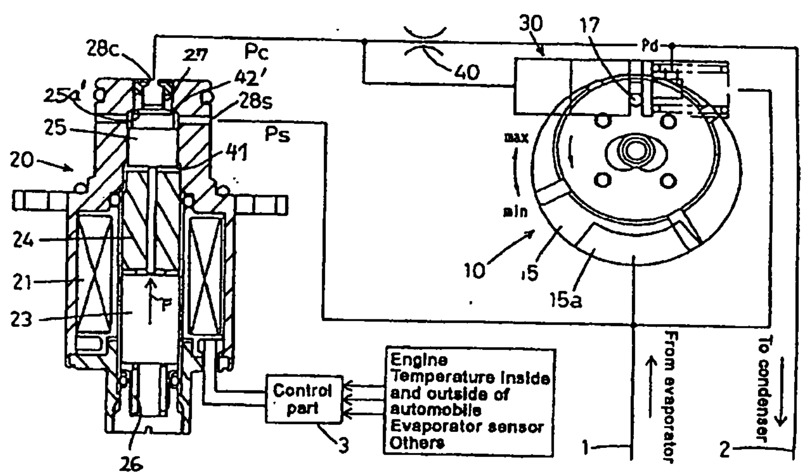

FIG 8

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EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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X	US 4 886 425 A (ITAHANA TSUTOMU ET AL) 12 December 1989 (1989-12-12) * abstract; figure 1 *	1,8	
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F04B
F04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 January 2001	Ingelbrecht, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 10 7247

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(54) **Capacity controller of a compressor with variable capacity**

Kapazitätsregelung für Verdichter mit veränderlicher Fördermenge

Unité de commande de capacité d'un compresseur à capacité variable

(84) Designated Contracting States:
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Description

[0001] The present invention relates to a capacity controller of a compressor having variable capacity used for a refrigerating cycle of an automobile air-conditioner or the like, according to the preamble part of claim 1 and to a method according to the preamble part of independent claim 5.

[0002] As the compressor in a refrigerating cycle of an automobile air conditioner directly is driven by the engine of the automobile the speed of the compressor cannot be controlled individually. In order to obtain proper refrigerating abilities without being limited by the engine speed compressors with variable capacity are used allowing to vary their capacity (the amount of discharged refrigerant) upon cooling or heating demand independent from the speed of the engine. The compressor may be a rotary compressor, a scroll compressor or a swash plate compressor. The capacity is controlled by controlling the inhalation pressure with the help of an energisation force brought onto a diaphragm by an electromagnetic solenoid. Due to said diaphragm also the pressure of the ambient air is applied. A capacity variation mechanism is controlled by the inhalation pressure. A capacity control mechanism having said diaphragm is complicated to operate, because the structure of the control mechanism is complicated and large in size, and because the available control range of the inhalation pressure is restricted. As a consequence, it is difficult, to control the compressor properly within a wide range of conditions.

[0003] In a solenoid actuated capacity controller as known from EP 0 864 749 A the valve closure part is a ball separated from the valve actuating piston body. The valve actuating piston body is loaded by spring force and the inhalation pressure in valve opening direction counter to the force generated by the control pressure. The value of the control pressure is controlled by controlling the opening and closing degree of the valve closure part relative to the valve seat, i.e. by opening or closing a flow connection from a discharge pressure port to said control pressure port. Simultaneously, said control pressure port permanently is connected to said inhalation pressure port via a throttling aperture in said valve actuation piston body. The thrust force generated by the solenoid acts against the force of a spring loading the valve closure part in closing valve direction.

[0004] The capacity varying mechanism of the compressor in US 5,056,990 A is directly actuated via a leakage passage by the discharge pressure of the compressor and counter to the force of the inhalation pressure. The control pressure is derived from said discharge pressure by the solenoid actuated capacity controller controlling a flow communication between the capacity variation mechanism and the inhalation side of the compressor. In the capacity controller a hollow valve spool is loaded by spring force to block said flow communication as long as no current is supplied to the solenoid. Depending on the current supplied to the solenoid the spool is shifted by magnetic attraction force gradually into the open state of said flow connection.

[0005] A capacity control device as known from US 4,886,425 A uses a diaphragm type actuator to control the control pressure value in strict dependence from the value of the inhalation pressure of the compressor. The control range for the control pressure is limited to the variation range of the inhalation pressure.

[0006] A variable displacement wobble plate type compressor as known from US 4,730,986 A employs two control valves to vary the compressor capacity. The first control valve is purely pressure responsive, while the second control valve is actuated by a solenoid.

[0007] Further prior art is contained in CH 257 521 A.

[0008] It is an object of the present invention to provide a capacity control apparatus of a compressor with variable capacity which can be of compact size and structurally simple and which allows to obtain wide control range, and to propose a method for controlling the capacity of the compressor properly within a broad pressure range.

[0009] Said task is achieved with the features contained in claim 1, and by the method as disclosed in independent claim 5.

[0010] According to the invention a wide control range is obtained with a compact and small sized control apparatus having a simple configuration. This is achieved by controlling the capacity of the compressor with the help of a differential pressure added to the inhalation pressure on an arbitrary level with the help of a controlling piston valve body, loaded inter alia by a solenoid. Additionally, the inhalation pressure is applied to the piston valve body so that a value of the differential pressure can be maintained and set arbitrary for the transmission into the capacity variation mechanism to correspondingly adjust the capacity of the compressor. Basically, the differential pressure used in connection with the inhalation pressure is derived from a discharge pressure of the compressor allowing to broaden the pressure variation range for the capacity variation mechanism. The inhalation pressure remains the leading control parameter. However, not only the inhalation pressure and/or its pressure variations control the capacity variation mechanism, but in addition an assistant differential pressure is taken from the discharge pressure of the compressor and is added. The magnitude of the differential pressure may be adjusted and varied by a solenoid, e.g. a proportional solenoid.

[0011] Embodiments of the invention will be described with the help of the drawings. In the drawings is:

Fig. 1 sectional views of a capacity controller, a capacity variation mechanism and a rotary compressor integrated into a refrigerating cycle of an automobile air conditioning system,

Fig. 2 a partial cross-section of the compressor

shown in Fig. 1,

Fig. 3 a partial cross-section of a detail of the compressor of Fig. 1,

Fig. 4 a schematic view of the capacity variation mechanism of Fig. 1,

Fig. 5 a view similar to Fig. 1, representing the condition of an adjustment of maximum capacity of the compressor,

Fig. 6 a view similar to Fig. 1, representing a condition of minimum capacity of the compressor,

Fig. 7 a diagram representing the control behaviour of the capacity control apparatus as used in Fig. 1, showing the value of a differential pressure over the capacity duty of the compressor, and

Fig. 8 a view similar to Fig. 1 containing a second embodiment of a capacity control apparatus.

[0012] Figs 1 to 8 show a rotary compressor 10 with variable capacity in conjunction with a capacity controller 20 and a capacity variation mechanism 30, together employed in a refrigerating cycle of an automobile air conditioner or the like. The compressor 10 has (Fig. 2) a circular housing 11 receiving a somewhat smaller circular rotor 12 disposed on an eccentric axis 13. Said rotor 12 is driven e.g. by the engine of the automobile (not shown). In the outer periphery of rotor 12 radially displaceable seal pieces 14 are biased outwardly by spring means such that they contact the inner surface of housing 11. At the closest position between the inner surface of housing 11 and periphery of rotor 12 a discharge port 19 is provided discharging compressed high pressure refrigerant into a discharge pressure duct 2. An inhalation duct 1 for low-pressure refrigerant supplied from an evaporator (not shown) communicates with an inhalation port 15a of an inhalation port control board 15. Port 15a allows to supply the low-pressure refrigerant into a compression chamber 18 of compressor 10. Board 15 has axial and oversized bore 16 for eccentric axis 13.

[0013] The capacity of the compressor 10 can be varied by increasing or decreasing the volume, i.e. the angular extension, of compression chamber 18, e.g. by rotating the inhalation control board 15 in order to displace the inhalation port 15a in rotary direction. Control board 15 has a protruding driving pin 17 which can be adjusted about the axis of board 15 by capacity variation mechanism 30.

[0014] Mechanism 30 in Fig. 4 controls the position of the driving pin 17 in order to control the rotary orientation of the inhalation port 15a of control board. In a cylinder 31 of mechanism 30 a piston 32 is moveable in axial direction. Driving pin 17 engages into a circumferential groove 32a of piston 32. An axial movement of piston 32 automatically displaces control board 15 about its axis. Piston 32 is loaded by a spring 32 in a direction adjusting the capacity of the compressor towards a minimum. Spring 32 is received within one part of cylinder 31. Said part of cylinder 31 is also connected to inhalation duct 1 such that the pressure inside said part of the cylinder 31 corresponds an inhalation pressure Ps of the compressor. The opposite part of cylinder 31 (at the other side of piston 32) is connected to a differential pressure port 28c of said capacity controller 20 which operates as a differential pressure controller. The pressure within the other part of cylinder 31 is a control pressure Pc the value of which is controlled by said controller 20. The higher said control pressure Pc is, the further piston 32 is displaced counter to spring 32 and the more control board 15 is rotated towards its position for maximum capacity of the compressor. The lower said control pressure Pc is, the more control board 15 rotated by spring 32 and inhalation pressure Ps towards its position of minimum capacity of the compressor 10.

[0015] Capacity controller 20, e.g. of Fig. 1, is a fixed differential pressure valve and includes a solenoid (coil 21, fixed iron core 22 and moveable iron core 23) for controlling said differential pressure also by the pressures at both ends of a piston valve body 25. The driving source of said solenoid is electromagnetic coil 21 to which electric current can be supplied upon demand (proportional solenoid, the actuation force of which directly is proportional to the value of current supplied to coil 21).

[0016] In addition springs 26, 27 are provided which act in opposite directions onto said piston valve body 25. The setting of both springs 26, 27 determines in the embodiment of Fig. 1 a basic maximum value of the differential pressure (Pc - Ps). Said value, however, can arbitrarily be decreased by feeding current into coil 21. Moveable iron core 23 is attracted the more by fixed iron 22, the stronger the current is. Moveable iron core 23 causes a thrust F which is transmitted to said piston valve body 25 via a rod 24 extending along the axis of fixed iron core 20. Thrust F is acting in opening direction of said differential pressure valve of said controller 20 in Fig. 1.

[0017] Said inhalation duct 1 is connected to an inhalation pressure port 28s provided in a side of a housing of controller 20 and behind the back or rear effective pressure area of piston valve body 25 which can be loaded in the same direction by the thrust F of moveable iron core 23.

[0018] Piston valve body 25 co-operates by a front end valve closure jaw part 25a with a valve seat 42 provided between a space 41 housing piston valve body 25 and axially disposed differential pressure port 28c. Differential pressure port 28c of controller 20 is connected to said other part of cylinder 31 on the side of piston 32 opposite to spring 33.

[0019] As a consequence, said control pressure Pc when controlled corresponds to the inhalation pressure Ps but is higher by an increment of pressure due to the thrust F caused by moveable iron core 23 (and the setting of springs 26, 27).

[0020] Discharge pressure duct 2 is connected to a discharge pressure port 28d of controller 20. Discharge pressure port 20d (discharge pressure Pd) opens in the vicinity of valve seat 42 at the circumferential side of piston valve body 25, so that discharge pressure Pd does not affect the piston valve body 25 in axial direction, i. e., piston valve body 25 is pressure balanced for discharge pressure Pd.

[0021] Said valve closure jaw part 25a formed at the front end of piston valve body 25 serves to open and close said valve seat 42 between discharge pressure port 28d and differential pressure port 28c. As soon as said valve jaw part 25a is lifted from valve seat 42 during a movement of piston valve body 25 with thrust F pressure Pd from discharge pressure duct 2 is transmitted via the open valve seat 42 into differential pressure port 28c, according to the initial control condition of the controller.

[0022] Whenever the value of the pressure at the differential pressure port 28c becomes lower than the fixed value of control pressure Pc, piston valve body 25 is moved towards its opening state such that a communication is established between the discharge pressure port 28d and differential pressure port 28c. As soon as then the value of the pressure at the differential pressure port 28c reaches the fixed value of the control pressure Pc, piston valve body 25 returns into its closing state and again separates said differential pressure port 28c from said discharge pressure port 28d.

[0023] Furthermore, e.g. outside of controller 20, differential pressure port 28c and inhalation pressure port 28s are directly interconnected via a leak passage 40 having a small cross-sectional area, e.g. provided in a connection between inhalation duct 1 and a duct connecting differential pressure port 28c with mechanism 30. As soon as valve closure jaw part 25a closes valve seat 42 the value of the pressure at the differential pressure port 28c is allowed to little by little relieve via leak passage 40 into inhalation duct 1. As a result, piston valve body 25 always axially and slightly moves and control pressure Pc is controlled to the fixed value, e.g. corresponding to the value of the electric current supplied to electromagnetic coil 21.

[0024] As shown in Fig. 5 the larger the value of the electric current in electromagnetic coil 21 is, the larger the pressure differential of (Pc - Ps) becomes, and the angular position of the inhalation port 15a is displaced in a direction towards (max) by capacity variation mechanism 30. As a result the capacity of the inhalation compression chamber 18 and consequently the discharge pressure Pd increase.

[0025] The smaller the value of the electric current in electromagnetic coil 21 is, the smaller is the differential pressure of (Pc - Ps), as shown in Fig. 6 and the angular position of inhalation port 15a is adjusted in the direction towards (min) by capacity variation mechanism 30. As a result, the capacity of said inhalation compression chamber 18 and the discharge pressure Pb both decrease.

[0026] As can be seen in Fig. 7 the capacity of compression chamber 18 of compressor 10 is varied corresponding to the differential pressure Pc - Ps by controlling the value of the electric current in electromagnetic coil 21.

[0027] The value of the electric current in electromagnetic coil 21 is controlled by inputting detected signals from an engine sensor, temperature sensors inside and outside of an automobile compartment, an evaporator sensor and a plurality of other sensors detecting specific kinds of conditions. Said signals are input into a control part 3 containing a CPU and the like. Said CPU processes the input signals and provides an output signal based on the respective operation results. The control signal is then output from control part 3 to electromagnetic coil 21, e.g. via a not shown driving circuit.

[0028] In a second embodiment of controller 20 shown in Fig. 8 piston valve body 25 is co-operating with valve seat 42' such that said valve seat 42' is closed by the front end closure part 25a' in the direction of thrust F generated by solenoid 21, 22, 23. In this embodiment discharge pressure port 28d is omitted. At the very same location instead inhalation pressure port 28s is provided. Discharge pressure duct 2 directly is connected via leak passage 40 to the duct connecting differential pressure port 28c to the left part of cylinder 31 of mechanism 30. Inhalation pressure port 28s of the embodiment of Fig. 1 is omitted. Inhalation pressure Ps can act on piston valve body 25 in the same direction as thrust F, namely towards the closing state. The pressure in differential pressure port 28c is acting in opening direction.

[0029] Springs 26, 27 determine a basic value of differential pressure Pc - Ps. Said value can be increased arbitrarily by increasing the value of the current supplied to electromagnetic coil 21.

[0030] As soon as due to pressure passing leak passage 40 the pressure at differential pressure port 28c rises beyond the fixed value of the control pressure Pc, piston valve body 25 is lifted from its valve seat 42'. A flow communication is established between differential pressure port 28c and inhalation pressure port 28s. Control pressure Pc drops to the fixed value. As soon as the pressure at the differential pressure port 28c has reached the fixed value of the control pressure Pc, piston valve body 25 returns again into its closed state. Again high pressure refrigerant passes through leak passage 40 to differential pressure port 28c in order to maintain the fixed value of the differential pressure Pc - Ps as adjusted by the value of the current for the coil 21.

[0031] In both embodiments high pressure refrigerant from the discharge pressure duct 2 is used to build up the fixed pressure value for the control pressure Pc,

however, influenced by the initial value of the inhalation pressure Ps.

[0032] The invention instead may be applied to control the capacity of a scroll compressor or the like instead of a rotary compressor 10 as shown.

Claims

1. Capacity controller (20) of a variable capacity compressor (10), comprising a pressure controlled capacity variation mechanism (30) at said compressor (10), the mechanism (30) being connected to said capacity controller (20) which is actuated by a solenoid to generate a variable control pressure (Pc) for said mechanism (30) on the basis of the initial value of the inhalation pressure (Ps) of said compressor (10), said capacity controller (20) including a valve seat (42, 42') situated between first and second valve chamber parts, and a piston-actuated valve closure part (25a, 25a') to open or close a communication passage between a differential pressure port (28c) connected to a control pressure receiving part of said mechanism (30) and a port (28d, 28s) connected to a compressor pressure line (1, 2), a pressure responsive piston member (25) movably provided in said second valve chamber part and loaded in valve-opening direction by a spring force, said piston member (25) having a pressure-receiving area loaded in valve-opening direction by the inhalation pressure (Ps) of said compressor, said solenoid (21, 22, 23) generating a thrust force (F) for actuating said valve closure part (25a, 25a') relative to said valve seat (42, 42') to vary said control pressure (Pc),
   characterised in that said valve closure part (25a, 25a') is unitarily formed at one end of said piston member (25), that ~~the solenoid is provided at the side of said piston member (25) remote from said valve closure part (25a, 25a')~~ and that the thrust force (F) directly acts upon said piston member (25).

2. Capacity controller as in claim 1, **characterised in that**
   said valve closure part (25a) is situated at the side of said valve seat (42) in said first valve chamber part which is connected to said differential pressure port (28c);
   said valve closure part (25a) has a pressure receiving area loaded in said first valve chamber part in valve-closing direction towards said valve seat (42) by said variable control pressure (Pc) present at said differential pressure port (28c);
   said thrust force (F) acts upon said piston member (25) in valve-opening direction, when said solenoid is supplied with current, the value of which determines the value of a differential pressure (Pc - Ps) between said control pressure (Pc) and said inhalation pressure (Ps) at said differential pressure port (28c);
   said differential pressure port (28c) is connected to said control pressure receiving part of a cylinder (31) of said mechanism (30) such that an increasing value of the differential pressure (Pc - Ps) adjusts the compressor capacity via said mechanism (30) towards a maximum; and
   said control pressure receiving part of said cylinder (31) of said mechanism (30) is connected by a leakage passage (40) with said inhalation line (1) of said compressor.

3. Capacity controller as in claim 1, **characterised in that**
   said valve seat (42') is located between said first valve chamber part which is connected to said differential pressure port (28c) and said second valve chamber part which is connected to said inhalation line (1);
   said valve closure part (25a') is situated in said second valve chamber part and has a pressure receiving area loaded in valve-opening direction by said variable control pressure (Pc) at said differential pressure port (28c);
   said thrust force (F) directly acts upon said piston member (25) in valve-closing direction when said solenoid is supplied with current, the value of which determines the value of a differential pressure (Pc - Ps) between said control pressure (Pc) and said inhalation pressure (Ps) at said differential pressure port (28c);
   said differential pressure port (28c) is connected to said control pressure receiving part of a cylinder (31) of said mechanism (30) such that an increasing value of said differential pressure (Pc - Ps) adjusts the compressor capacity via said mechanism (30) towards a maximum; and
   said control pressure receiving part of said cylinder (31) of said mechanism (30) is connected by a leakage passage (40) with a discharge line (2) of said compressor.

4. Capacity controller as in claim 2 or 3, **characterised in that** said differential pressure (Pc - Ps) is increased from a set value the higher the value of the current supplied to said solenoid is.

5. A method for controlling the capacity of a variable capacity compressor (10) by a pressure controlled capacity variation mechanism (30) and a solenoid actuated capacity controller (20), said controller generating a variable control pressure (Pc) for said mechanism (30) corresponding to variations of the inhalation pressure (Ps) of said compressor (10)
   characterised in that
   an expanded adjustment range of the value of a dif-

ferential pressure (Pc - Ps) between said control pressure (Pc) actuating said mechanism (30) and said inhalation pressure (Ps) is controlled by the value of the current supplied to the solenoid (21, 22, 23); and
in that an initially-set value of said differential pressure (Pc - Ps) is maintained either by adding via said capacity controller (20) pressure taken from a discharge line (2) of said compressor to said control pressure (Pc) and by permanently relieving a part of said control pressure (Pc) via a leakage passage (40) into an inhalation line (1) of said compressor, or by relieving via said capacity controller (20) a part of said control pressure (Pc) into the inhalation line (1) and by permanently adding pressure taken via a leakage passage (40) from the discharge line (2) to said control pressure (Pc).

Patentansprüche

1. Kapazitätscontroller (20) eines Kompressors (10) mit variabler Kapazität, umfassend einen druckgesteuerten Kapazitätseinstellmechanismus (30) an dem Kompressor (10), wobei der Mechanismus (30) mit dem Kapazitätscontroller (20) verbunden ist, welcher betätigt wird durch einen Solenoid zum Generieren eines variablen Steuerdrucks (Pc) für den Mechanismus (30) auf der Basis des initialen Werts des Ansaugdrucks (Ps) des Kompressors (10), wobei der Kapazitätscontroller (20) einen zwischen ersten und zweiten Ventilkammerteilen angeordneten Ventilsitz (42, 42') und einen kolbenbetätigten Ventilschließteil (25a, 25a') zum Öffnen oder Schließen einer Verbindungspassage aufweist, die sich erstreckt zwischen einem Differenzialdruckanschluss (28c), der mit einem dem Steuerdruck aufnehmenden Teil des Mechanismus (30) verbunden ist, und einem Anschluss (28d, 28s), der mit einem Kompressordruckstrang (1, 2) verbunden ist, wobei in dem zweiten Ventilkammerteil ein auf Druck ansprechendes Kolbenglied (25) beweglich angeordnet und in Ventilöffnungsrichtung durch eine Federkraft beaufschlagt ist, welches Kolbenglied (25) eine Druckaufnahmefläche aufweist, die in Ventilöffnungsrichtung durch den Ansaugdruck (Ps) des Kompressors belastet ist, und wobei der Solenoid (21, 22, 23) eine Schubkraft (F) zum Verstellen des Verschließteils (25a, 25a') relativ zu dem Ventilsitz (42, 42') zum Variieren des Steuerdrucks (Pc) generiert,
dadurch gekennzeichnet, dass der Ventilschließteil (25a, 25a') an einem Ende des Kolbenglieds (25) einstückig angeformt ist, dass der Solenoid an der Seite des Kolbenglieds (25) abgewandt von dem Ventilschließteil (25a, 25a') angeordnet ist, und dass die Schubkraft (F) direkt auf das Kolbenglied (25) einwirkt.

2. Kapazitätscontroller nach Anspruch 1, **dadurch gekennzeichnet,**
dass der Ventilschließteil (25a) an der Seite des Ventilsitzes (42) in dem ersten Ventilkammerteil angeordnet ist, der mit dem Differenzialdruckanschluss (28c) verbunden ist;
der Ventilschließteil (25a) eine Druckbeaufschlagungsfläche aufweist, die in dem ersten Ventilkammerteil in Ventilschließrichtung zu dem Ventilsitz (42) durch den variablen Steuerdruck (Pc) beaufschlagt wird, der an dem Differenzialdruckanschluss (28c) vorliegt;
die Schubkraft (F) auf das Kolbenglied (25) in Ventilöffnungsrichtung einwirkt, sobald der Solenoid mit Strom beaufschlagt wird, dessen Wert den Wert eines Differenzialdrucks (Pc - Ps) zwischen dem Steuerdruck (Pc) und dem Ansaugdruck (Ps) an dem Differenzialdruckanschluss (28c) bestimmt;
der Differenzialdruckanschluss (28c) verbunden ist mit dem den Steuerdruck aufnehmenden Teil eines Zylinders (31) des Mechanismus (30), derart, dass ein zunehmender Wert des Differenzialdrucks (Pc - Ps) die Kompressorkapazität über den Mechanismus zu einem Maximum verstellt; und
der den Steuerdruck erhaltende Teil des Zylinders (31) des Mechanismus (30) über eine Leckagepassage (40) mit dem Ansaugstrang (1) des Kompressors verbunden ist.

3. Kapazitätscontroller nach Anspruch 1, **dadurch gekennzeichnet, dass**
der Ventilsitz (42') zwischen dem ersten Ventilkammerteil, der mit dem Differenzialdruckanschtuss (28c) verbunden ist, und dem zweiten Ventilkammerteil angeordnet ist, der mit dem Ansaugstrang (1) verbunden ist;
der Ventilschließteil (25a') in dem zweiten Ventilkammerteil angeordnet ist und eine Druckbeaufschlagungsfläche aufweist, die in Ventilöffnungsrichtung durch den variablen Steuerdruck (Pc) an dem Differenzialdruckanschluss (28c) beaufschlagt ist;
die Schubkraft (F) auf das Kolbenglied (25) direkt in Ventilschließrichtung einwirkt, sobald der Solenoid mit Strom beaufschlagt ist, dessen Wert den Wert eines Differenzialdrucks (Pc - Ps) zwischen dem Steuerdruck (Pc) und dem Ansaugdruck (Ps) an dem Differenzialdruckanschluss (28c) bestimmt;
der Differenzialdruckanschluss (28c) mit dem dem Steuerdruck empfangenden Teil eines Zylinders (31) des Mechanismus (30) derart verbunden ist, dass ein zunehmender Wert des Differenzialdrucks (Pc - Ps) die Kompressorkapazität über den Mechanismus (30) zu einem Maximum verstellt; und
der den Steuerdruck erhaltende Teil des Zylinders (31) des Mechanismus (30) über eine Leckagepassage (40) mit einem Ausschiebedruckstrang (2) des Kompressors (10) verbunden ist.

4. Kapazitätscontroller nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** der Differenzialdruck (Pc - Ps) ausgehend von einem gesetzten Wert erhöht wird, um so höher der Wert des dem Solenoid zugeführten Stroms ist.

5. Verfahren zum Regeln der Kapazität eines Kompressors (10) mit variabler Kapazität durch einen druckgesteuerten Kapazitätsverstellmechanismus (30) und einen solenoidbetätigten Kapazitätscontroller (20), wobei der Controller einen variablen Steuerdruck (Pc) für den Mechanismus (30) generiert korrespondierend mit Variationen des Ansaugdrucks (Ps) des Kompressors (10),
dadurch gekennzeichnet, dass
ein expandierter Einstellbereich für den Wert eines Differenzialdrucks (Pc - Ps) zwischen dem den Mechanismus (30) betätigenden Steuerdruck (Pc) und dem Ansaugdruck (Ps) eingesteuert wird durch den Wert des Stroms, der dem Solenoid (21, 22, 23) zugeführt wird; und
ein initial eingestellter Wert des Differenzialdrucks (Pc - Ps) aufrechterhalten wird entweder durch Addieren von durch den Kapazitätscontroller (20) von einem Ausschiebedruckstrang (2) des Kompressors abgenommenem Druck zu dem Steuerdruck (Pc) und durch permanentes Abbauen eines Teils des Steuerdrucks (Pc) über eine Leckagepassage (40) in einen Ansaugstrang (1) des Kompressors, oder durch Abbauen eines Teils des Steuerdrucks (Pc) über den Kapazitätscontroller (20) in den Ansaugstrang (1) und durch permanentes Hinzuaddieren von über eine Leckagepassage (40) aus dem Ausschiebedruckstrang (2) abgenommenem Druck zu dem Steuerdruck (Pc).

Revendications

1. Unité de commande de capacité (20) d'un compresseur à capacité variable (10), comprenant un mécanisme de variation de capacité à commande par pression (30) disposé sur ledit compresseur (10), le mécanisme (30) étant connecté à ladite unité de commande de capacité (20) qui est commandée par un solénoïde afin de générer une pression de commande variable (Pc) destinée audit mécanisme (30) en fonction de la valeur initiale de la pression d'aspiration (Ps) dudit compresseur (10), ladite unité de commande de capacité (20) comprenant un siège de clapet (42, 42') situé entre une première et une seconde partie de chambre de clapet, et une partie de fermeture de clapet actionnée par piston (25a, 25a') destinée à ouvrir ou à fermer un passage de communication entre un orifice de pression différentielle (28c) connecté à une partie de réception de pression de commande dudit mécanisme (30) et un orifice (28d, 28s) connecté à une conduite de pression de compresseur (1, 2), un élément de piston répondant à la pression (25) aménagé de manière mobile dans ladite seconde partie de chambre de clapet et chargé dans la direction d'une ouverture de clapet par une force de ressort, ledit élément de piston (25) comprenant une surface de réception de pression chargée dans la direction d'une ouverture de clapet par la pression d'aspiration (Ps) dudit compresseur, ledit solénoïde (21, 22, 23) générant une force de poussée (F) destinée à actionner ladite partie de fermeture de clapet (25a, 25a') par rapport audit siège de clapet (42, 42') afin de faire varier ladite pression de commande (Pc),
caractérisée en ce que ladite partie de fermeture de clapet (25a, 25a') est formée de manière unitaire sur une extrémité dudit élément de piston (25), **en ce que** le solénoïde est disposé sur le côté dudit élément de piston (25) à distance de ladite partie de fermeture de clapet (25a, 25a'), et **en ce que** la force de poussée (F) agit directement sur ledit élément de piston (25).

2. Unité de commande de capacité selon la revendication 1, **caractérisée en ce que** :

ladite partie de fermeture de clapet (25a) est située sur le côté dudit siège de clapet (42) dans ladite première partie de chambre de clapet qui est connectée audit orifice de pression différentielle (28c) ;
ladite partie de fe rmeture de clapet (25a) comprend une surface de réception de pression chargée dans ladite première partie de chambre de clapet dans une direction de fermeture de clapet vers ledit siège de clapet (42) par ladite pression de commande variable (Pc) présente dans ledit orifice de pression différentielle (28c) ;
ladite force de poussée (F) agit sur ledit élément de piston (25) dans une direction d'ouverture de clapet, lorsque ledit solénoïde est alimenté par un courant dont la valeur détermine une valeur de pression différentielle (Pc - Ps) entre ladite pression de commande (Pc) et ladite pression d'aspiration (Ps) audit orifice de pression différentielle (28c) ;
ledit orifice de pression différentielle (28c) est connecté à ladite partie de réception de pression de commande d'un vérin (31) dudit mécanisme (30) de sorte qu'une valeur croissante de la pression différentielle (Pc - Ps) règle vers le maximum la capacité du compresseur par l'intermédiaire dudit mécanisme (30) ; et
ladite partie de réception de pres sion de commande dudit vérin (31) dudit mécanisme (30) est connectée par un passage de fuite (40) à ladite conduite d'aspiration (1) dudit compresseur.

3. Unité de commande de capacité selon la revendication 1, **caractérisée en ce que** :

ledit siège de cla pet (42') est situé entre ladite première partie de chambre de clapet qui est connectée audit orifice de pression différentielle (28c) et à ladite seconde partie de chambre de clapet qui est connectée à ladite conduite d'aspiration (1) ;
ladite partie de fermeture de clapet (25a') est située dans ladite seconde partie de chambre de clapet et comprend une surface de réception de pression chargée dans une direction d'ouverture de clapet par ladite pression de commande variable (Pc) audit orifice de pression différentielle (28c) ;
ladite force de poussée (F) agit directement sur ledit élément de piston (25) dans une direction de fermeture de clapet lorsque ledit solénoïde est alimenté par un courant dont la valeur détermine la valeur d'une pression différentielle (Pc - Ps) entre ladite pression de commande (Pc) et ladite pression d'aspiration (Ps) audit orifice de pression différentielle (28c) ;
ledit orifice de pression différentielle (28c) est connecté à ladite partie de réception de pression de commande d'un vérin (31) dudit mécanisme (30), de sorte qu'une valeur croissante de ladite pression différentielle (Pc - Ps) règle vers le maximum la capacité du compresseur par l'intermédiaire dudit mécanisme (30) ; et
ladite partie de réception de pression de commande dudit vérin (31) dudit mécanisme (30) est connectée par un passage de fuite (40) à une conduite de décharge (2) dudit compresseur.

4. Unité de commande selon la revendication 2 ou la revendication 3, **caractérisée en ce que** ladite pression différentielle (Pc - Ps) est accrue d'autant plus que la valeur de courant appliquée audit solénoïde est élevée à partir d'une valeur fixe.

5. Procédé de commande de la capacité d'un compresseur à capacité variable (10) par un mécanisme à variation de capacité commandé par pression (30) et par une unité de commande de capacité commandée par solénoïde (20), ladite unité de commande générant une pression de commande variable (Pc) destinée audit mécanisme (30) correspondant à des variations de la pression d'aspiration (Ps) dudit compresseur (10),
caractérisé en ce que :

une plage de réglage étendue de la valeur d'une pression différentielle (Pc - Ps) entre ladite pression de commande (Pc) qui agit sur le mécanisme (30) et ladite pression d'aspiration (Ps) est commandée par la valeur du courant qui appliquée au solénoïde (21, 22, 23) ; et
en ce qu'une valeur initialement réglée de ladite pression différentielle (Pc - Ps) est maintenue soit en additionnant par l'intermédiaire de ladite unité de commande de capacité (20) une pression prise à partir d'une conduite de décharge (2) dudit compresseur à ladite pression de commande (Pc) et en libérant en permanence une partie de ladite pression de commande (Pc) par l'intermédiaire d'un passage de fuite (40) à l'intérieur d'une conduite d'aspiration (1) dudit compresseur, ou en libérant par l'intermédiaire de ladite unité de commande de capacité (20) d'une partie de ladite pression de commande (Pc) à l'intérieur de la conduite d'aspiration (1) et en additionnant en permanence une pression prise par l'intermédiaire d'un passage de fuite (40) à partir de la conduite de décharge (2) à ladite pression de commande (Pc).

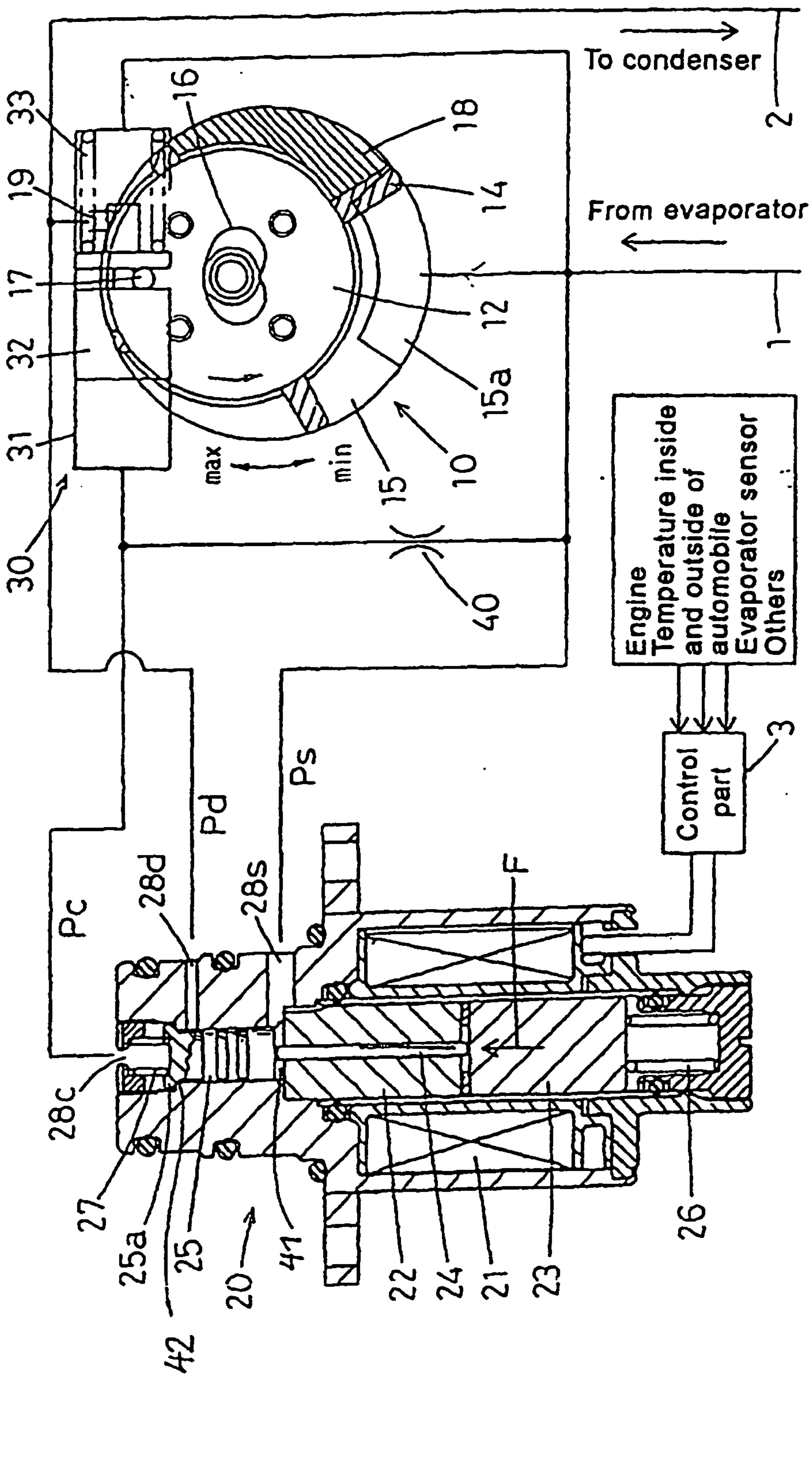

To condenser
From evaporator
Engine
Temperature inside
and outside of
automobile
Evaporator sensor
Others
Control part
max
min
Pc
Pd
Ps
F
1
2
3
10
12
14
15
15a
16
17
18
19
20
21
22
23
24
25
25a
26
27
28c
28d
28s
30
31
32
33
40
41
42

FIG1

FIG 2

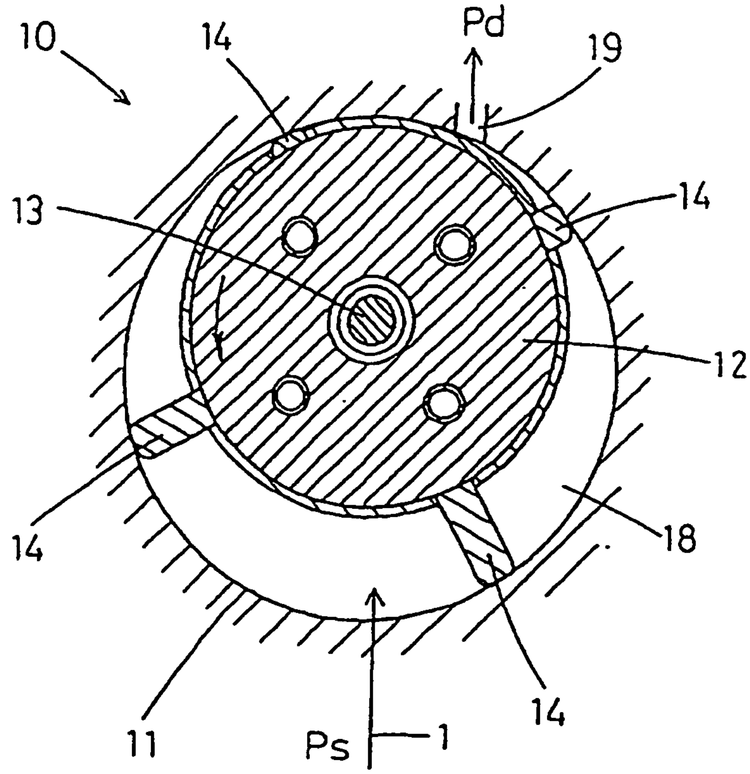


FIG 3

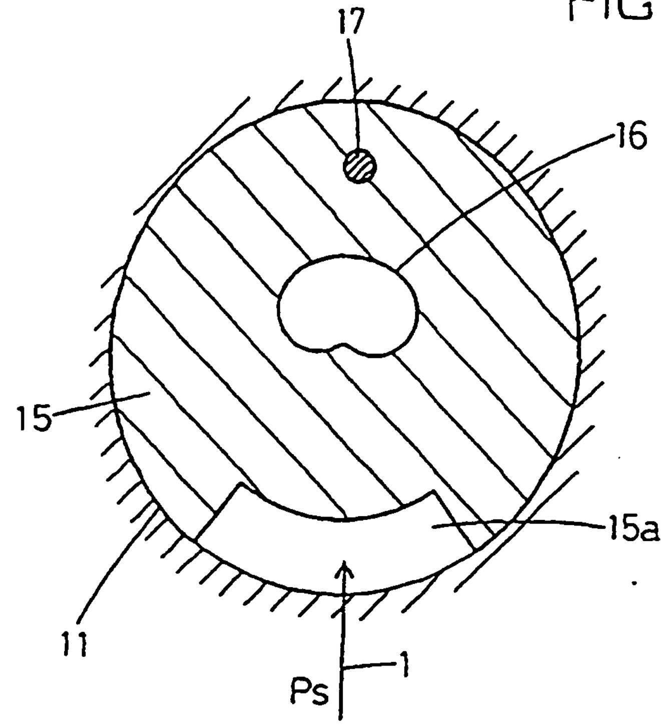
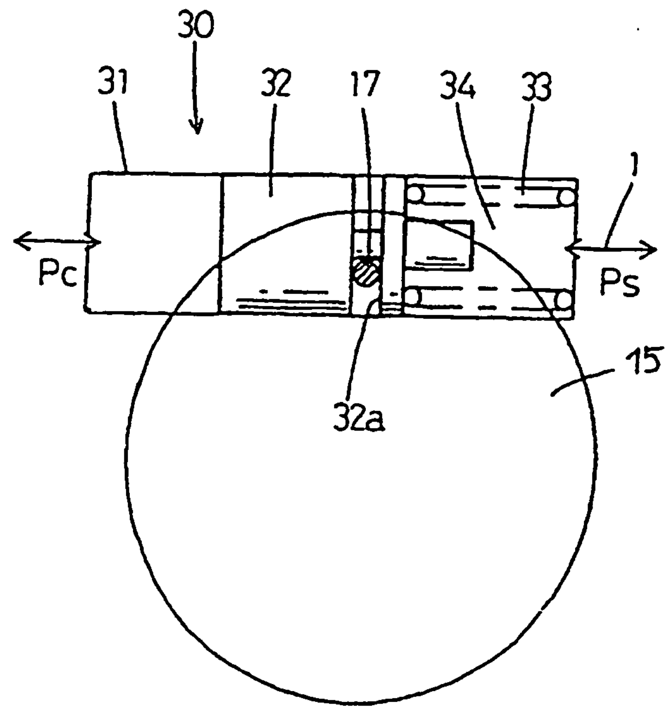


FIG 4



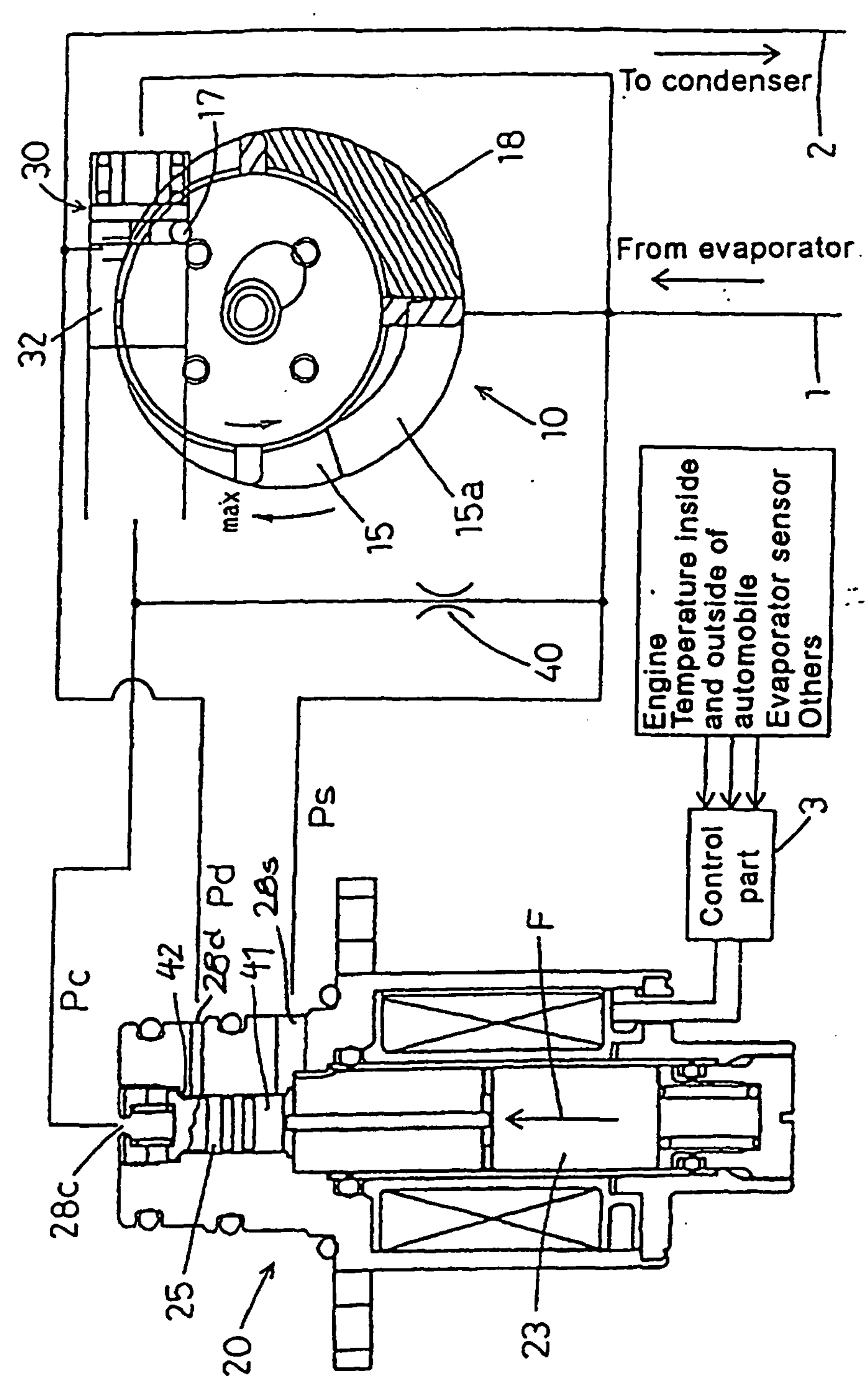

To condenser
From evaporator
30
17
18
2
32
1
10
15a
15
max
40
Engine
Temperature inside
and outside of
automobile
Evaporator sensor
Others
3
Control part
Ps
Pd
28s
28d
41
42
Pc
F
28c
25
20
23

FIG 5

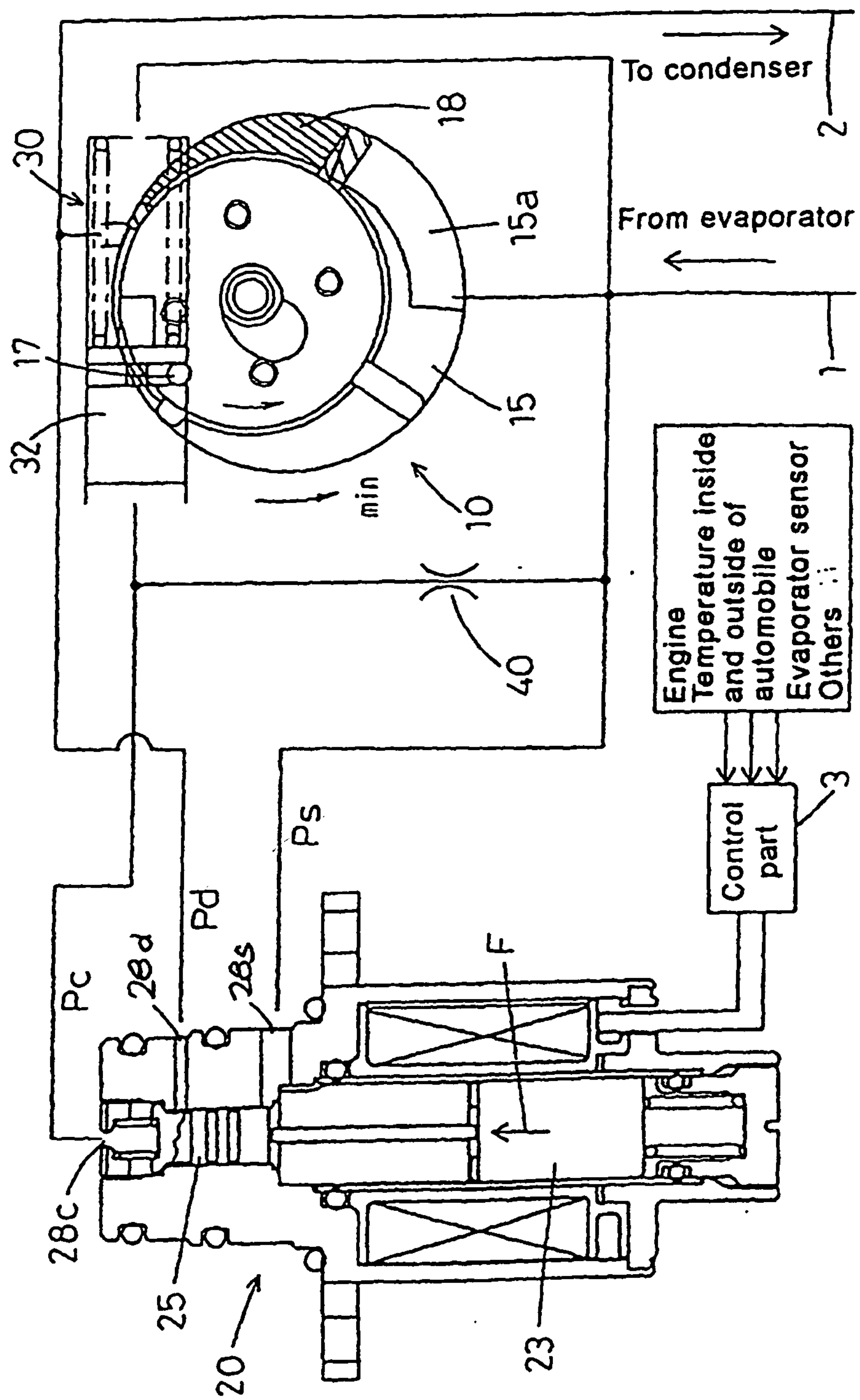
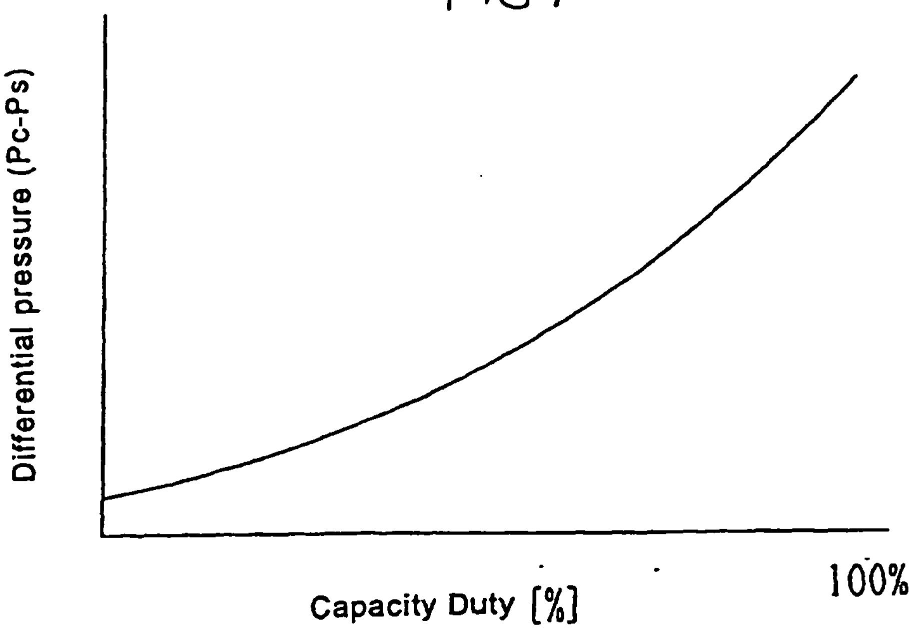

To condenser
From evaporator
2
1
18
15a
15
30
17
32
10
min
40
Engine
Temperature inside
and outside of
automobile
Evaporator sensor
Others
Control part
3
Ps
Pd
Pc
28d
28s
28c
25
20
23
F

FIG 6

FIG 7



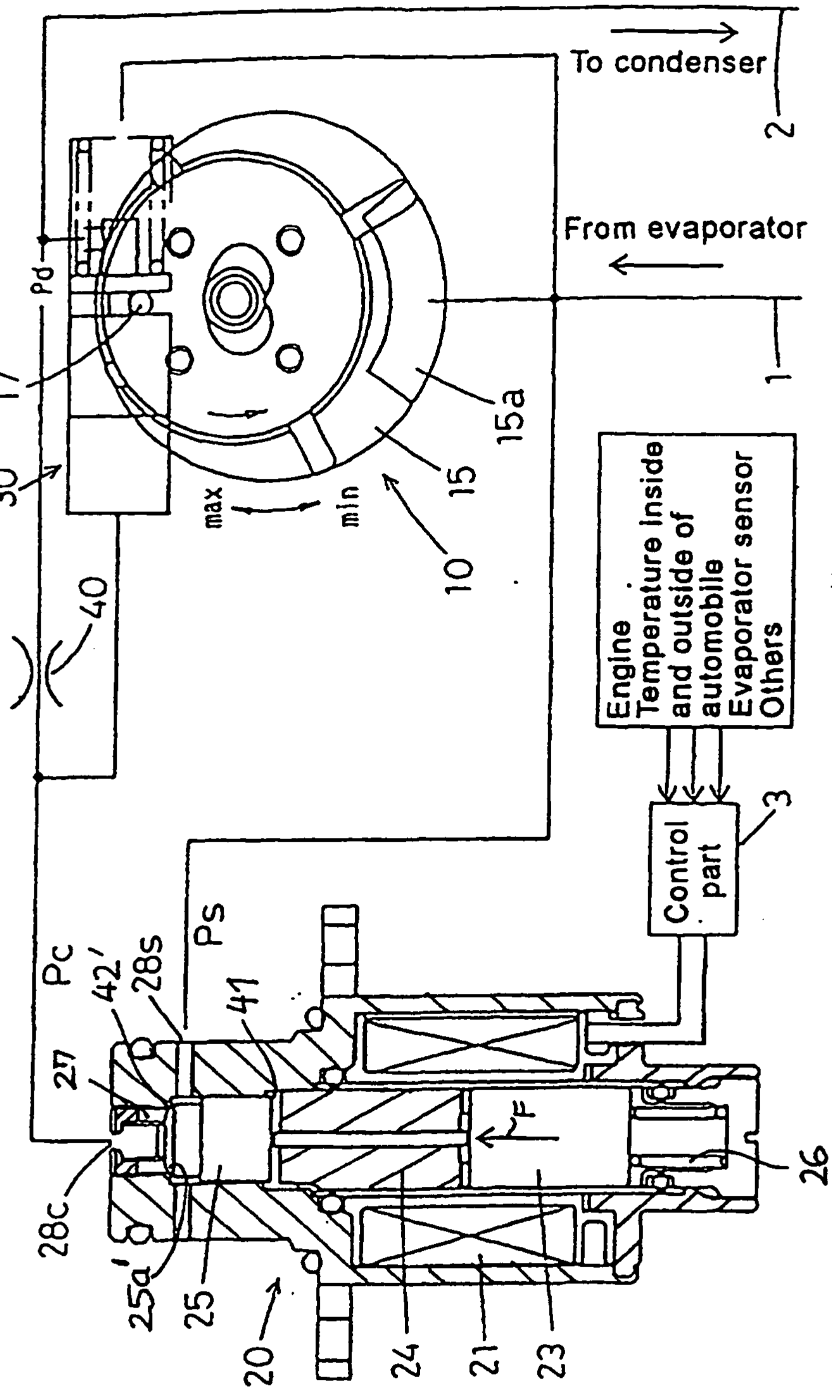

To condenser
2
From evaporator
1
Pd
17
30
40
15a
15
10
max
min
Engine
Temperature inside and outside of automobile
Evaporator sensor
Others
3
Control part
Pc
Ps
42'
28s
41
27
28c
25a
25
20
24
21
23
26
F

FIG 8